The GROUP-C Experiment
GPS Radio Occultation and Ultraviolet Photometry – Colocated

**AT A GLANCE**

**What is it?**
GROUP-C comprises a downward-viewing high-sensitivity ultraviolet airglow photometer and a GPS radio occultation receiver that jointly measure horizontal and vertical ionospheric gradients from the ISS. The focus is upon the density and structure of the nighttime ionosphere.

**How does it work?**
Naturally-occurring ionospheric airglow is mapped in the ultraviolet to reveal its horizontal structure below the ISS. GPS signals are monitored as GPS satellites set below the horizon to provide vertical electron densities. Combining the simultaneous vertical and horizontal measurements yields regional 2-D tomographic maps of ionospheric structures. GROUP-C combined with the LITES experiment form a powerful lower ionospheric observatory on the space station.

**What will it accomplish?**
These low-cost, compact space sensors demonstrate advanced methods to characterize ionospheric structure on regional scales, highly relevant to Navy/DoD operational systems, including over-the-horizon radar (OTHR), communications, and precision geolocation.

**R&D Sponsor(s)**
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**Left:** The GROUP-C experiment includes (counterclockwise from lower right) the ultraviolet photometer, support electronics, the GPS receiver, and the GPS patch antenna array. The ultraviolet photometer was developed at NRL, the GPS receiver was from Cornell University, and three patch antennas were provided by The Aerospace Corporation with support from the Office of Naval Research. **Right:** The GROUP-C antenna array is the prominent “face” of the STP-H5 payload, integrated and launched under the DoD Space Test Program, launched in February 2017.

**Objectives**
- Measure Earth’s ionospheric electron density using GPS radio occultations and measure the nighttime ion density using ultraviolet airglow photometry.
- Investigate ionospheric morphology and variability relevant to global ionospheric models, to electromagnetic signal propagation, and to ionospheric disturbances which can cause scintillation.

**Approach**
- GROUP-C remotely senses the ionosphere passively to characterize both its vertical structure and the horizontal gradients in the orbital plane.
  - The software-defined dual-frequency GPS receiver derives vertical electron density and scintillation from GPS satellite occultations behind the ISS.
  - The high-sensitivity 135.6nm ultraviolet photometer measures in-track horizontal ionosphere gradients directly beneath the ISS.
- Computerized tomography techniques combine horizontal and vertical data to generate a 2-D map of the ionosphere in the ISS orbital plane, particularly focused on the lower F-region ionosphere, relevant to DoD and Navy applications.

**Payoffs**
- GROUP-C serves as risk reduction for advanced ionospheric sensing techniques planned in future space missions, including
  - the US-UK Coordinated Ionospheric Reconstruction Cubesat Experiment (CIRCE) dual nanosatellite mission;
  - the Persistent Volumetric Ionospheric Sensing of Targeted Areas (Persistent VISTA) mission concept, designed to provide improved OTHR decision aids for the Navy.
- GROUP-C can also supply real-time space weather data suitable for use in DoD’s Global Assimilation of Ionospheric Measurements (GAIM) operational model, which can help mitigate expected space environmental coverage gaps arising from the cancellation of the DMSP F20 satellite.